Moral hazard in a voluntary deposit insurance system: Revisited

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Summary. This paper extends Wheelock and Kumbhakar's (1995) test for moral hazard in the Kansas deposit insurance system —1910-1920. This paper tests and finds evidence of omitted bank-specific effects. Estimates in Wheelock and Kumbhakar (1995), as a result, are biased. This paper introduces unobserved individual heterogeneity to the test for moral hazard, corrects their estimates, and finds more evidence of moral hazard in the Kansas deposit insurance system.

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Moral Hazard in a Voluntary Deposit Insurance System: Revisited

1. Introduction.

Wheelock and Kumbhakar's (1995) —W&K henceforth— provide empirical evidence of the perverse incentives that deposit insurance systems may have on banks' risk-taking behavior. W&K report evidence of both adverse selection and moral hazard in the Kansas deposit insurance system early in the twentieth century. This paper extends W&K moral hazard test by introducing unobserved individual heterogeneity. Exploiting the panel data information structure of the sample is a natural extension to W&K. Furthermore, there is evidence —i.e., Wheelock and Wilson (1995)— that suggests that W&K might have omitted variables that convey bank specific information. This paper tests and finds evidence of unobserved heterogeneity across banks. W&K's estimates, as a result, are biased. In particular, W&K failed to find the statistically significant negative effect that bank insurance membership had on bank *surplus/loans* ratio. This paper improves W&K test for moral hazard, corrects their estimates, and finds more evidence of moral hazard.

2. Data Set.

The data set Wheelock and Kumbakhar made available includes a random sample of 212 banks that operated in Kansas from 1910 to 1920, which we then adjusted by

excluding 8 banks that had been open for less than a year by 1910 since those were not eligible for deposit insurance in that year.[1] The data set covers the years 1910, 1914, 1918, and 1920, for which bank balance sheets are available. Our data set, then, includes information for 204 banks; in contrast, W&K report using a data set with 205 banks. Furthermore, 427 out of our 816 observations report insured status, whereas W&K report 438 out of their 820 observations with insured status. In sum, we do not work with exactly the same sample as W&K.

Table 1 presents the definition of the variables of study. *DI* is the dummy variable for bank insurance status. Four alternative financial ratios are used as proxies for bank risk-taking behavior. In general, *Age*, *Bankpop*, and *DIratio* contain information about the competition banks faced; whereas *ΔImpacre*, *ΔLandvalue*, *ΔPop*, and *Rural* contain information about local economic and demographic conditions.[2]

[Table 1 about here]

3. Moral Hazard Test.

A test for moral hazard involves contrasting the risk-taking behavior of insured versus uninsured agents. Moral hazard would be present in a deposit insurance system if,

[1] "We omit banks that were ineligible for insurance system membership because of insufficient capital or age, including all banks that opened after the insurance system was begun." (Wheelock and Kumbhakar, 1995, p. 193.)

[2] See W&K for details on the variables.

after controlling for other factors, insured banks engage in riskier behavior than uninsured banks. W&K test for moral hazard in the Kansas deposit insurance system involves the use of Grossman's (1992) two-stage estimation process: equation (1) is estimated as a Probit model to produce the estimate for bank insurance membership, $\overline{DI}$, which is then included as a regressor in the least-squares estimation of equation (2).[3]

$$DI = f_1(Age, DIratio, Bankpop) \tag{1}$$

$$R = f_2(\overline{DI}, Age, Bankpop, Rural, \Delta Pop, \Delta Impacre, \Delta Landvalue) \tag{2}$$

where, $R = \{capital/assets,\ \ surplus/loans,\ \ cash/deposits,\ \ loans/assets\}$

The parameter estimate for $\overline{DI}$ —in equation (2)—, thus, determine whether the Kansas deposit insurance system suffered from moral hazard. Kansas deposit insurance system suffered from moral hazard if the parameter estimate for $\overline{DI}$ is statistically significant and has a negative sign for R={*capital/assets*, *surplus/loans*, *cash/deposits*} or positive for R={*loans/assets*}.[4] The data set excludes those banks that began operations after the insurance system started. Thus, "banks that might have opened for the purpose of exploiting the insurance system are thus excluded, and hence our results should *understate*

[3] Grossman (1992) procedure is followed in order to avoid the selectivity bias that would be present if equation (2) were to be estimated with *DI* as a regressor. That is, a bank risk preference would determine its decision whether to join the deposit insurance system.

[4] "Option-theoretic model of deposit insurance, such as Merton's (1977), predict that banks will find it optimal to maintain lower capital/asset ratios and more risky asset portfolios with insurance than they would in the absence of insurance." (Wheelock and Kumbhakar, 1995, p. 196.) "The capital/asset ratio is not the only possible risk measure available to us, and we also test whether deposit insurance caused differences across banks in the other financial ratios identified by White (1984) and Wheelock (1992) as useful predictors of bank failure in this area. If moral hazard characterized the Kansas insurance system, we expect to find that

the extent of adverse selection and moral hazard in the Kansas system." (Wheelock and Kumbakhar, 1995, p. 193.)

4. Estimation Results.

We performed moral hazard tests as W&K but for the inclusion of unobserved bank-specific effects.[5] Exploiting the panel data information structure of the sample is a natural extension to W&K. Furthermore, in contrast to what W&K implicitly assume, Wheelock and Wilson (1995) show that state-chartered Kansas banks during 1910-1928 were non-homogenous in technical efficiency. This paper, thus, introduces heterogeneity into W&K estimation process in order to capture some of the bank specific effects that might have been left out in W&K moral hazard tests.

Probit model (1) with unobserved heterogeneity is estimated using random individual effects, given that the fixed effect probit model renders inconsistent estimates and some incidental parameters may not be estimated —Green (2000), Hsiao (2003).[6] Moral hazard regression model (2) with unobserved heterogeneity is estimated using fixed effects, in order to maintain the OLS estimation procedure in the second stage of the test.[7]

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insurance system membership had a negative impact on the surplus/loan and cash/deposit ratios of insured banks, and a positive impact on their loans/assets ratios." (Wheelock and Kumbhakar, 1995, p. 197.)

[5] "We pool the observations on each bank in the simple across the tour years for which data are available." (Weelock and Kumbhakar, 1995, p. 196.)

[6] Fixed effects probit model was estimated and tested against the random effect model. According to Hausman specification test, the null hypothesis of random effect cannot be rejected at a ten percent confidence level. Also, the incidental parameter could not be estimated for 104 banks; that is, 416 observations were bypassed.

[7] Estimation of equation (2) assuming random bank specific effects does not change the conclusions obtained

The software NLOGIT, v. 3.0.10, is used to estimate the regression models.

Estimation results for the first stage of the estimation process are reported in table 2, which includes probit and random effect probit estimates, as well as probit estimates reported in W&K for comparison purposes.[8] Besides the regressors listed in table 2, regional and annual dummy variables are also included in order to control for systematic differences across state regions and time.

According to both likelihood ratio and Hausman tests, one can reject the null hypothesis that bank specific effects are not significant at the one percent confidence level. W&K probit estimates, as a result, are biased. Random effect probit estimates do not reverse the sign of probit estimates or their statistical significance, but they are significantly larger —in absolute value— than probit estimates. Random effects probit estimation of bank insurance membership is used in the second stage of the moral hazard test.

[Table 2 about here]

Estimation results for bank risk regressions are reported in table 3, which includes least squares (OLS) and fixed effects (FEM) estimates, as well as the least squares estimates reported in W&K's table 4 (W&K OLS) for comparison purposes.[9] OLS renders

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from the fixed effect estimation procedure.

[8] Both probit and W&K probit have the same model specification; however, as is discussed in section 2, our sample is not be exactly the same as in W&K.

[9] OLS and W&K OLS does not have the same model specification. W&K OLS includes the probit estimate

the same evidence of moral hazard as W&K: bank insurance membership has a statistically significant negative effect on the *capital/assets* ratio, but not on the other financial ratios. However, both F- and likelihood ratio tests conclude that the null hypothesis of no fixed effects can be rejected at the one percent confidence level. W&K estimates, thus, are biased again. Moral hazard test should be then based on FEM results, which conclude that bank insurance membership has a statistically significant negative effect on both *capital/assets* and *surplus/loans* ratios.

[Table 3 about here]

There is evidence, then, that the Kansas deposit insurance system suffered from moral hazard. Insured banks, for instance, held a *capital/assets* ratio that on average was 1.15 percentage points smaller than uninsured banks.[10] In contrast, W&K estimated that insured banks held a *capital/assets* ratio that on average was 2.81 percentage points smaller than uninsured banks. On the other hand, insured banks held a *surplus/loans* ratio that on average was 1.32 percentage points smaller than uninsured banks.[11] In contrast, W&K found no significant effect of bank insurance membership on bank *surplus/loans* ratio. Finally, like W&K, this paper finds no evidence that bank insurance membership was a determinant of bank *cash/deposit* and *loans/assets* ratios.

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of $\overline{DI}$ as a regressor; in contrast, OLS includes the random effects probit estimate of $\overline{DI}$ as a regressor.

[10] The average *capital/assets* ratio for all banks is 17.05 percent.

[11] The average *surplus/loans* ratio for all banks is 8.91 percent.

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Table 1. Definition of Variables.

Variable	Definition
DI	Deposit Insurance Status: 1, insured bank; 0, otherwise.
Age	The number of years between a bank's charter date and balance-sheet date.
Bankpop	The number of state chartered banks in a county divided by county population.
Diratio	The ratio of insured to total state banks in a county.
ΔImpacre	The percentage change in county improved farm acreage, 1910 to 1920.
ΔLandvalue	The percentage change in county farm land value per acre, 1910 to 1920.
ΔPop	The percentage change in county population, 1910 to 1920.
Rural	The proportion of a county population located on farms or towns less than 2,500 persons.
capital/assets *surplus/loans* *cash/deposits* *loans/assets*	These financial ratios are used as alternative measures for banks' risk-taking behavior.

Table 2. Probit Model: Dependent Variable, *DI*.

Variable	W&K Probit[1]		Probit		Random Effects Probit	
	Parameter	Derivative	Parameter	Derivative	Parameter	Derivative
Age	0.01 **		0.016 **	0.006	0.081 **	0.010
	1.96		*2.16*	*2.16*	*2.23*	*2.23*
DIratio	3.65 ***		3.635 ***	1.448	10.793 ***	1.276
	12.39		*12.11*	*12.12*	*6.67*	*6.74*
Bankpop	-0.03		-0.146	-0.058	-0.254	-0.030
	-0.16		*-0.68*	*-0.68*	*-0.23*	*-0.23*
Constant	-1.56 ***		-2.339 ***	-0.932	-7.643 ***	-0.904
	-4.95		*-7.92*	*-7.87*	*-4.89*	*-4.87*
ρ					0.912	
					47.97	
Log-L			-369.39		-250.56	
% Correct	78		78.55		78.92	
N = 820	DI = 0 for 382 obs		N = 816	DI = 0 for 389 obs		
			LR test: χ^2_1 = 237.65; p-value = 0.0000			
			Hausman test: h = 183.49; p-value = 0.0000			

[1] Estimates as reported in W&K, equation (1).
t-statistics are reported in cursive; statistical significance: ***, 1%; **, 5%; *, 10%.

Table 3. Moral Hazard Test: Stage 2. Dependent Variables: *capital/assets*, *surplus/loan*, *cash/deposits*, *loans/assets*.[a]

	capital/assets			*surplus/loans*			*cash/deposits*			*loans/assets*		
Variable	W&K OLS[b,c]	OLS[c]	FEM	W&K OLS[b,c]	OLS[c]	FEM	W&K OLS[b,c]	OLS[c]	FEM	W&K OLS[b,c]	OLS[c]	FEM
DI	**-2.810 *****	**-1.538 *****	**-1.151 ****	-0.990	-0.652	**-1.316 *****	-0.380	-0.140	0.315	-1.820	-0.545	-0.741
	-3.10	*-2.98*	*-2.05*	*-1.27*	*-1.48*	*-2.95*	*-0.21*	*-0.13*	*0.24*	*-1.09*	*-0.55*	*-0.60*
Age	-0.010	-0.008	-0.023	0.160 ***	0.168 ***	0.120	0.020	0.020	-0.471	-0.060	-0.072	0.262
	-0.32	*-0.29*	*-0.13*	*5.93*	*6.28*	*0.83*	*0.46*	*0.39*	*-1.08*	*-1.32*	*-1.59*	*0.65*
Bankpop	0.210	1.118	4.555 *	1.730 *	2.209 **	1.441	-8.080 ***	-8.443 ***	-31.161 ***	9.930 ***	10.017 ***	31.637 ***
	0.16	*0.86*	*1.92*	*1.68*	*2.14*	*0.76*	*-3.75*	*-3.92*	*-5.50*	*5.37*	*5.40*	*6.04*
Rural	3.770	4.236 ***		1.470	1.380		4.650 **	5.486 **		-2.020	-2.734	
	2.90	*3.22*		*1.37*	*1.30*		*2.09*	*2.43*		*-1.03*	*-1.37*	
ΔPop	0.020 ***	0.021		0.020	0.020		-0.010	-0.006		0.030	0.023	
	1.00	*1.30*		*1.24*	*1.62*		*-0.39*	*-0.22*		*1.35*	*0.97*	
ΔImpacre	-0.001	-0.004		-0.030 ***	-0.035 ***		-0.010	-0.009		0.020	0.023	
	-0.12	*-0.24*		*-2.41*	*-2.56*		*-0.45*	*-0.27*		*0.77*	*0.81*	
ΔLandvalue	0.030	0.045 **		0.000	0.007		0.040	0.049		-0.030	-0.026	
	1.55	*2.39*		*0.17*	*0.40*		*1.22*	*1.64*		*-1.20*	*-0.97*	
Constant	10.550 ***	15.281 ***		4.570 ***	4.134 ***		27.270 ***	36.999 ***		67.380 ***	63.952 ***	
	5.36	*11.33*		*3.08*	*3.54*		*7.62*	*13.50*		*21.78*	*26.58*	
R^2	0.3200	0.3495	0.7655	0.1000	0.1273	0.7145	0.2300	0.2368	0.5947	0.2200	0.2181	0.5938
Adj R^2		0.3389	0.6846		0.1132	0.6160		0.2244	0.4550		0.2054	0.4538
d. f.		802	606		802	606		802	606		802	606
s.d.e(i)		0.0572	0.0395		0.0479	0.0315		0.1129	0.0946		0.1055	0.0874
	OLS vs FEM			OLS vs FEM			OLS vs FEM			OLS vs FEM		
F-test	$F_{(203,606)}$ = 5.73, p-value = .0000			$F_{(203,606)}$ = 6.35, p-value = .0000			$F_{(203,606)}$ = 2.97, p-value = .0000			$F_{(203,606)}$ = 2.97, p-value = .0000		
LR-test	X^2_{203} = 874.14; p-value = .0000			X^2_{203} = 929.89; p-value = .0000			X^2_{203} = 563.50; p-value = .0000			X^2_{203} = 563.68; p-value = .0000		

[a] Reported coefficients are 100 times larger than their actual value; t-statistics are reported in cursive; statistical significance: ***, 1%; **, 5%; *, 10%.

[b] W&K OLS are the estimates reported in table 4 in W&K, where $\overline{DI}$ was estimated using a probit model.

[c] Standard errors were corrected for heteroscedasticity.